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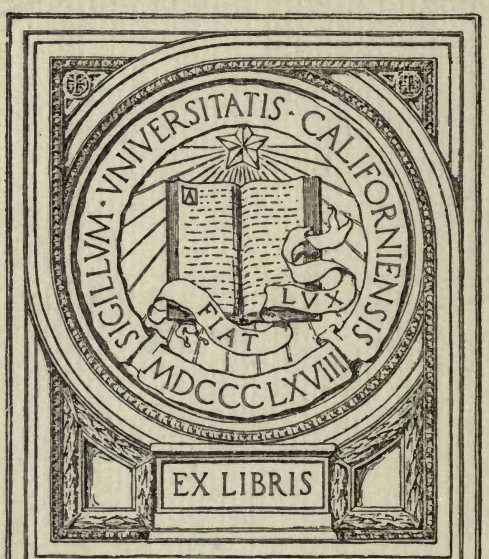

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PUBLICATIONS OF
THE TRAINING SCHOOL AT VINELAND NEW JERSEY
DEPARTMENT OF RESEARCH

SENSORY DISCRIMINATION IN NORMAL AND FEEBLE MINDED CHILDREN

BY
ANNA M. PETERSEN
AND
E. A. DOLL

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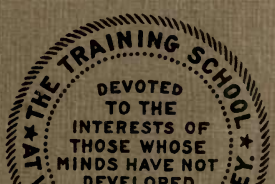

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Sensory Discrimination in Normal and Feeble-Minded Children

An Experimental Study of Discrimination of Lifted Weights in Relation to Mental Age.

by

Miss Anna M. Petersen,

Formerly Research Student at The Training School,

and

E. A. Doll

Assistant Psychologist, The Training School at Vineland.

A real and growing need is felt at present for information concerning the mental differences of normals and defectives[1] of the same mental but of different chronological ages. The typical defective is insipid, barren of original ideas, lacking in inhibition, poor in judgment, with no intellectual curiosity, and his accomplishments are the results of prolonged training and experience. The normal child of the same mental age is original, inquisitive, vivacious, full of initiative. As Binet aptly expresses it (1, p. 122)[2]:

> "The impression that is obtained when one passes some time with an imbecile or an idiot is that they are literally *les pauvres d'esprit.* They do not differ from normals in the same way as do certain types of dements by unexpected and sometimes unique and bizarre phenomena, which are like extra attachments to an already known mechanism; the difference is not one of more but of less. *The defective is a normal who lacks something.*[3]
>
> "But what is the nature of this defect? If ever the idea of higher and lower processes had an opportunity for application in psychology, it is certainly among the individuals of this species. One feels that it is especially the higher part of the intelligence, the finest and the most delicate that has not developed in them. They are reduced to the coarsest and therefore the simplest, the most elementary, the most general in man."

The Binet Scale furnishes intellectual standards for comparing normals and defectives, but there is a serious lack of comparative study on the

[1]Thruout this article the term "defective" is used synonymously with "feeble-minded."
[2]Numbers in parentheses refer to the appended list of references.
[3]Italics ours.

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sensory, motor, acquisitive, affective, attentive, and volitional capacities. These problems, confronting the study of mental defectives, have led us to undertake a series of experiments on the sensory capacities of the feeble-minded in an attempt to present experimental evidence bearing on their mental constitution exclusive of the purely intellectual factors to determine, if possible, whether the defective's lack is one of sensory capacity. Heretofore it has been quite generally accepted, and we ourselves at first believed, that in sensory capacity defectives are inferior to normals of the same chronological ages, and even of the same mental ages. We offer this experiment as the first of a series planned to test the validity of this assumption. A subordinate purpose of the experiment was two-fold:

(a) To establish norms of performance in the discrimination of weights for all ages and types of feeble-mindedness, and

(b) To determine the value of the discrimination of weights test as a diagnostic test with normal and defective children.

The discrimination of weights has been used for so many different purposes and under such different methods that it is hardly worth while to review here the history of the experiment. A sufficiently extended historical review is to be had in Whipple's presentation (8, p. 189). Burt and Moore say of the test (2, p. 366):

> "The consciousness of movement, position, and strain is not popularly recognized among the five senses. The existence, however, of the sixth, or *"muscle sense,"* with sense organs of its own deep in the structures of the muscles, tendons, and joints, is now beyond dispute. It forms the chief of the two senses which yield us information as to the welfare and whereabouts of the body and its parts, and which are therefore classified as 'proprioceptive.' It is indeed one of the oldest and most important of all the senses; older, perhaps, even than cutaneous touch. Its acuity may be tested by the power to discriminate lifted weights."

Material.

Our conduct of the test was the same as that outlined in Whipple's Manual (8, p. 190), but, having reason to believe that the discrimination of defectives would be less acute than that of normals, we varied the series of weights which Whipple recommends, in which the finer differences in weight are at the lower end of the series, and make our series more finely differentiated at the upper end. It would have been still better had our weights been of only slight differences at *both* ends. Our set consisted of 17 paste-board cartridge shells filled with shot and stuffed, to prevent rattling; 2 standard weights of 80 g. each, and 15 comparison weights forming the series, 82 g., 84 g., 86 g., 88 g., 90 g., 91 g., 92 g., 93 g., 94 g., 95 g., 96 g., 97 g., 98 g., 99 g., 100 g. Other apparatus consisted of a large card-board screen with adjustable support.

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Method.

Great care was taken in the conduct of the test. In language appropriate to the particular child, keeping always the same sense, *E*, the experimenter, painstakingly and with copious illustrations outlined the specific manner in which the weights were to be handled. Instructions were given positively, and "don'ts" were avoided as much as possible. *S*, the subject, was seated comfortably beside a table, with the screen adjusted at a height of 15 cm. over the wrist of his "favored" arm, which lay naturally on the table, resting on the elbow, with upper arm parallel to the upright position of the body. *E*, seated at the end of the table on the other side of the screen, placed a weight between *S's* thumb and first two fingers, which, holding lightly, *S* then raised to the height of the screen by a steady movement of the forearm from the elbow. He immediately returned the weight to the table with the same even movement and at once received from *E* a second weight, which he raised and lowered in the same manner, reporting as soon as he had set it down whether it was heavier or lighter than the first.

Judgments of "equal" or "the same" were not accepted unless insisted upon, and if accepted were marked incorrect, *S* having been instructed to guess whenever the weights appeared to be equal. In this manner *E* conducted a number of preliminary trials between the standard weight and various comparison weights, beginning at the upper end of the series, in order to familiarize *S* with the test and also to determine roughly the probable limen.

A number of test series were then made in the region of the probable limen until the exact limen had been accurately determined by a comparison weight which yielded 8 judgments correct out of 10. Each test series consisted of 10 comparisons between the standard weight, S, and a single comparison weight, C, in which S was 5 times the first and 5 times the second weight in constant paired comparisons of: (1) S-C, (2) C-S, (3) C-S, (4) S-C, (5) S-C, (6) S-C, (7) C-S, (8) S-C, (9) C-S, (10) C-S, for each test series. The exact limen was further limited by comparison weights yielding 7 out of 10 and 9 out of 10 judgments correct. In case two or more comparison weights gave 8/10 correct, test series were repeated to reduce this space-limen to a point-limen, but, if the space-limen persisted, an average was taken of all the comparison weights giving 8/10 judgments correct between the limits of 7/10 and 9/10.

After experimenting with some 25 cases it was found advisable to modify the procedure in two particulars. Instead of reporting in terms of the second weight they were allowed to report which was the heavier weight. The other modification was the permission to lift with thumb

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and fore-finger instead of thumb and first two fingers. These modifications do not affect the data significantly on the quantitative side. Qualitatively, they make the test intellectually less difficult.

The testing was all conducted by Miss Petersen during the spring of 1913. For the Institution cases the tests were conducted in a small test-room of the Research Laboratory under favorable conditions. For the school children the tests were made in cloakrooms and hallways of the school building under less favorable conditions. Two 80-g. standard weights were alternated to avoid distractions of temperature or roughness from handling.

Subjects.

The subjects of the experiment consisted of a group of feeble-minded children and adults, and a group of normal children. The tests were first conducted with all the available "children" (inmates) of The Training School at Vineland, New Jersey, regardless of selection of any kind, except that no idiots (defectives with mental age below three years) were included, as it is evident from experience in many other experiments of this relatively complicated type that idiots cannot comprehend the directions. This group therefore includes all grades (excluding idiots), all mental and pathological types, and all chronological ages of feeble-mindedness. The subjects were examined in random order. The final tabulations include a total of 203 cases out of 226 examined, some few cases having been thrown out by reason of insufficient or inaccurate data (due, for instance, to very rapid fatigue, enforced interruption of tests, and the like).

Being unable to find in the literature of the subject any standards available for comparison, based on the same method of experimentation, we were constrained to carry out the tests with a group of normal children. For this purpose we desired a group which we could use for comparison by mental age. A group of normal children of the same chronological ages as the mental ages of the defectives was necessary to satisfy these requirements.*

These subjects included all types of school children from the ages of 5 to 14, but no feeble-minded children were included in the final average. So far as possible our cases were taken from children who had one or more Binet tests as determinants of normality. These were not at all selected cases, but represented random samplings of the schools. In cases where no Binet tests had been made upon the child his normality or defectiveness was determined by other criteria. There resulted 262 cases available out of 277 examined.

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*To Superintendent Reber, of the Vineland Public Schools, and to his teachers, we are very much indebted for the courtesy and co-operation they afforded in allowing us to work with the children enrolled under their care.

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All Defectives

Age	Cases	Type I No.	Type II No.	Type II Av.	Type II m. v.	Type II Limits	Type III No.	Type III Av.	Type III m. v.	Type III Limits	Modes
					Totals						
3	2	2									
4	12	8	4	13.5	3.5	8-20					
5	19	13	6	12.3	3.0	6-18					
6	34	11	11	14.4	3.1	10-20	12	9.5	1.3	6-12	9
7	43	7	14	11.0	2.4	4-18	22	9.5	3.0	4-20	6
8	44	2	0				42	7.4	1.6	4-14	6
9	22	0	0				22	7.7	2.5	4-14	6
10	18	1	0				17	6.1	1.4	4-10	8
11	8	0	0				8	6.0	1.5	3- 8	8
12	1	0	0				1	6.0			
	203	44	35	12.6	3.2	4-20	124	7.8	1.9	3-20	6
					Males						
3	1	1									
4	8	5	3	11.3	2.2	8-14					
5	13	9	4	11.0	3.0	6-14					
6	22	9	7	16.0	2.9	10-20	6	9.7	1.2	8-12	10
7	21	4	6	8.7	1.6	6-12	11	9.6	3.9	4-20	8
8	27	1	0				26	7.7	1.3	6-12	8
9	15	0	0				15	7.2	2.4	4-14	6
10	13	1	0				12	7.3	1.1	6-10	8
11	6	0	0				6	7.3	2.1	3- 8	8
12	1	0	0				1	6.0			
	127	30	20	12.1	2.4	6-20	77	7.9	1.9	3.20	8
					Females						
3	1	1									
4	4	3	1	20.0							
5	6	4	2	15.0	3.0	12-18					
6	12	2	4	12.0	2.0	10-14	6	9.3	1.6	6.12	10
7	22	3	8	13.0	3.8	4-18	11	9.3	2.2	6.14	10
8	17	1	0				16	6.9	1.9	4.14	6
9	7	0	0				7	7.9	2.1	6.12	6
10	5	0	0				5	5.2	1.4	4- 8	4
11	2	0	0				2	7.0	1.0	6- 8	7
	76	14	15	13.5	3.2	4-18	47	7.7	1.9	4-14	6

"Pure Feeble-Minded"---Type III

Age	Males No.	Males Av.	Females No.	Females Av.	Totals No.	Totals Av.
6	4	9.5	4	10.5	8	10.0
7	9	10.2	9	8.4	18	9.3
8	23	7.7	14	6.7	37	7.3
9	12	7.5	3	6.0	15	7.2
10	10	7.4	5	5.5	15	6.7
11	5	5.2	2	8.0	7	6.0
12	1	6.0	0		1	6.0
	64	7.9	37	7.4	101	7.7

Table 1—Tabulation of results obtained with 203 defectives of all ages and types. "Pure Feeble-minded" represents defectives with pathological types excluded.

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RESULTS WITH THE FEEBLE-MINDED.[4]

It is seen at the outset that on a basis of mental-age classification, defectives are first of all separated into three different types (see Table I and Curves 1 and 2). There is a group, Type I, composed of those who fail entirely in the test. They do not comprehend the directions, or at least are incapable of following them. There is a second group, Type II, of those who are unable to do the test in the prescribed way (successive lifting with the same hand), but who are able to compare by simultaneous lifting, by "hefting" and comparing with both hands at the same time. The third group, Type III, includes those who are able to perform the test in the accepted manner by successive lifting. It is with this third group that we shall most concern ourselves, altho the other two need by no means be discarded. From Curve 1, based on the data in Table I, which graphically presents the percentages of these types at the several mental ages we note that:

(1) All defectives of a mental age below four years are unable to follow the directions, or at least are unable to discriminate two weights (within the limits of our apparatus) when presented to them for comparison. They constitute entire failure, which consists in total lack of understanding of what is desired of them, or else manifests itself by haphazard attempts at guess-work compliance, but with no apparent discrimination by any method. It is possible that this group would be smaller and that some few would add themselves to Type II had our weights been of wider differences. This type steadily decreases in number with increase of mental capacity, and, with the exception of a single insane case which disturbs the curves at 10 years, ceases to be present after the mental age of 8. We are not warranted in concluding that the cases of this type are totally lacking in sensory capacity, but only that our experimental method does not enable us to measure whatever capacity they may have. Our test is intellectually too difficult for them (see 1, p. 125 ff; also L'Année Psych., 1908, p. 17).

(2) At the mental ages of 4 to 7 years there is an intermediate type of children who are able to discriminate between two weights compared simultaneously, but who are unable to compare them by successive lifting. Here again it is probable that intellectual difficulties obscure sensory measurement. Types I and II are qualitatively different from Type III, and are therefore excluded from the averages for Type III.

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[4]Chronological ages in these results are taken to nearest birthdays, and mental ages to nearest full years as measured by the Binet Scale. Classification of defectives by mental age includes wide ranges of chronological ages, and *vice versa*. For the normal children mental and chronological ages are practically identical.

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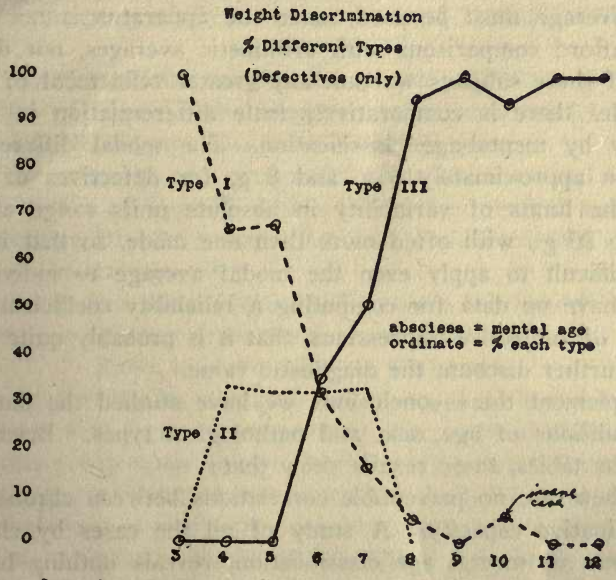
(3) It is not until the mental age of 7 that even half of the cases at any age are able to succeed under the conditions of the test. It follows, that in so far as a single test may be said to be diagnostic, inability to compare two weights by successive lifting is diagnostic of an intellectual level of less than 8 years, since at no age before do three-fourths of the cases succeed. If we accept both simultaneous and successive lifting the test is diagnostic, with defectives, at 6 years.[5]



Curve 1.---Showing percentage of the three types at each mental age.

We may dispose of Type I for the present, and rather summarily of Type II, since they do not conform to the conditions of the test. An inspection of Table I shows for Type II an average DL (difference limen) of 12.6 g., with a rather high degree of variability (m. v. = 3.2), the limits of discrimination ranging from 4 g. to 20 g.

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[5]Binet and Simon, using weighted cubes ranging from 3 to 18 grams, and accepting any manner of comparison, concluded that "it is not until the age of 5 that children succeed in this test" (L'Annee Psych., 1908, p. 16), and accordingly placed the test at 5 years in their Measuring Scale. From our results it appears that the test is easy for normals at 5 and difficult for defectives at 6. For a good discussion of the operations involved, see loc. cit., p. 17.

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Confining the discussion to Type III, we have first to consider the method of statistical treatment. For purposes of qualitative study thru numerical measures we have made use of weighted arithmetic averages. This treatment shows a constant increase in average discriminative capacity with increase in mental age (see Table 1 and Curve 2). The correlation between mental age and discriminative capacity proved to be positive though low: $r = +.36$[6], P. E., .053.

The accompanying mean variations, moreover, are fairly small, with an average coefficient of variability of .25. But the variability in terms of absolute test-units is quite wide, and for individual or diagnostic study the modal average must be used, since the apparatus is not sufficiently delicate to afford comparisons with arithmetic averages, nor do the performances of these subjects warrant any greater refinement of apparatus.

By modes there is comparatively little differentiation in discriminative capacity by mental-age classification. The modal difference limens vary between approximately 6 g. and 8 g. for defectives of Type III. Moreover, the limits of variability in absolute units range all the way from 3 g. to 20 g., with often more than one mode, so that it would be extremely difficult to apply even the modal average to individual diagnosis. We have no data for computing a reliability coefficient[7], but feel, on the basis of subjective impressions, that it is probably quite low. This would still further discount the diagnostic value.

To supplement these conclusions we have studied the data with respect to conditions of age, sex, and pathological types. Briefly, without presenting the tables, these results show that:

(1) There are no perceptible correlations between chronological age and discriminative capacity. A study of all the cases by chronological age, regardless of mental age classification, reveals nothing but the distribution of these mental ages at the chronological ages. Arranged in order of chronological age within mental age classification, computation of r's at the mental ages of 8, 9, and 10, where there are a sufficient number of cases, gives $r = +.17$, $+.19$, and $-.24$, respectively, indicating no relationship between age and capacity.

(2) The average performances of defective boys is approximately the same as that of girls, better at some ages and worse at others, with a total

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[6]The sign of r depends on whether the second term of the correlation is considered as increase in discriminative capacity or decrease in DL's. In the actual computations, using mental age for the first term and DL for the second, r has the sign $-$, but to avoid confusion, because we are speaking of increase in capacity rather than decrease of DL we have called the sign $+$. In other words, if we had plotted our curves and computed our correlations, using reciprocals of DL to indicate increase in discrimination rather than DL itself, we should have obtained curves sloping upwards and r's with signs $+$.

[7]"The coefficient of correlation between two sets of results thus obtained (by repeating the test at least once, if possible by a different observer working in ignorance of the results obtained by the first) from the same test measures the self-consistency of that test, and is called its coefficient of reliability." (3, p. 5.)

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sex superiority of 2.5% in favor of the girls. Rather curiously, this superiority rises to 6.5% when the pathological types have been eliminated, leaving the "pure feeble-minded" (lower part of Table 1).

(3) Of 9 epileptics, 4 are of Type I and 5 are of Type III. They range in mental age from 3 to 9 years, but show no definite differences from the averages for the mental ages at which they classify.

(4) Of 2 macrocephalics, both are of Type III and accord with their mental age average.

(5) Of 8 markedly insane cases (feeble-minded with insane complications), 3 whose mental ages warrant their being of Type III are actually of Type I, 1 is properly of Type II, and 4 are of Type III with noticeably high DL's.

(6) Of 9 Mongolians ranging in mental age from 4 to 6 years, all but one are of Type II, the exception being of Type I. Here, as in many other tests, the Mongolians form a distinct group.

(7) Very curiously, of a group of 6 acute ataxic cases 1 is of Type I (mental age 7), 1 is of Type II, with a DL of 8 g. (mental age 11), 2 are of Type III, with a DL of 6 g. (ages 8 and 11), and 2 are of Type III, with a DL of 10 g. (mental ages 6).

(8) Twenty-nine cases (14% of all) were left-handed. Their performances are not different from the averages for their mental ages.

Results with Normal Children.

Taking up the results obtained with normal children it is at once clearly apparent that there are some very characteristic differences. The subjects of this group range in age from 5 to 14 years. They are all able to perform the test as directed and within the limits of our apparatus, and their performances are not only somewhat better in average numerical values but also in a greater degree of reliability. Specifically, from Table 2 and Curve 2:

(1) There is a steady increase in average discriminative capacity with increase of age; $r = +.63$, P.E., .025. For ages 5 to 12, $r = +.65$, P.E., .025.

(2) The accompanying mean variations are quite low, the coefficient of variability ranging from .10 to .20, and the limits of variability are not very wide.

(3) The modal average is more reliable than is the case with defectives, but is not to be relied upon for the same reasons that apply in their case. Here also we have no data for computing the reliability coefficient, but feel that altho low it would be appreciably higher than with defectives.

(4) There are no appreciable sex differences. At 5 points boys' DL's are higher and at 4 are lower, the differences at these points being very slight. In the total averages for the ages below 13 there is a superiority of 5.5% in favor of the boys.

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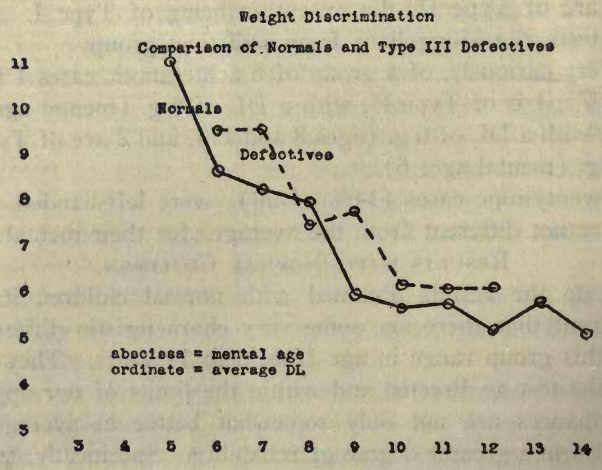
Comparing these results of normals with those for defectives:

(1) Curve 2 shows graphically that at all points but one the discrimination of normals is better than that of defectives. The differences, however, are apparent only for the weighted averages and the differences are but slight, amounting to 1 g. for the total average of each group. In absolute DL's the differences are not perceptible until computed.

(2) Defectives are more variable than normals (total m.v.'s of 1.9 and 1.1, respectively) and show greater individual differences. Subjectively, the conduct of the test with them is more difficult and the apparent reliability somewhat less.



Curve 2.---Showing comparative performances of normals and defectives at the same mental ages.

(3) Defectives are less capable than normals in following the directions of the experiment. This may be due to weaker comprehension of the *Aufgabe* or to weaker learning capacity, but probably is not due to weaker sensory capacity.

(4) Sex differences are slight, being about the same in amount but opposite in sex; for the defectives a superiority of 2.5%, rising to 6.5% for "pure feeble-minded", in favor of the girls, and for normals 5.5% in favor of the boys.

(5) Correlation with mental age is positive for both groups, but is considerably lower for defectives than for normals; $r = +.36$ and $+.65$, respectively.

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Normal Children.

Totals.

Age.	Cases.	Av.	m.v.	Limits.	Mode.
5	8	11.0	2.8	6–20	10
6	19	8.6	1.0	7–12	8
7	26	8.2	1.0	6–12	8
8	35	7.9	1.2	6–12	8
9	30	5.9	.6	4– 8	6
10	35	5.6	.9	4– 8	6
11	49	5.7	1.0	2–10	6
12	33	5.1	1.2	4– 8	4
13	21	5.7	.7	4– 8	6
14	6	5.0	1.0	4– 6	4
	235	6.7	1.1	2–20	6

Males.

5	4	11.0	4.5	6–20	10
6	6	9.0	1.3	8–12	8
7	13	7.7	1.3	6–10	8
8	16	7.8	1.5	6–12	6
9	16	5.8	.6	4– 8	6
10	17	5.7	.8	4– 8	6
11	27	5.8	1.0	4– 8	6
12	18	4.9	.9	4– 6	4
13	13	6.0	.3	4– 8	6
14	5	5.2	1.0	4– 6	6
	117	6.5	.8	4–20	6

Females.

5	4	11.0	1.0	10–12	11
6	13	8.4	1.0	7–10	8
7	13	8.6	1.3	6–12	8
8	19	8.1	.9	6–10	8
9	14	6.0	.6	4– 8	6
10	18	5.6	.8	4– 8	6
11	22	5.6	1.5	2–10	6
12	15	5.4	1.4	4– 8	4
13	8	5.1	.9	4– 6	6
14	1	4.0	..	....	..
	118	6.9	.6	2–12	6

Table 2.—Tabulation of results obtained with 262 normal public school children. The averages in this table are taken for the years below 13 for the purpose of comparing totals with defectives of the same mental ages.

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Comparison of These Results with Others.

Normal Capacity.

In comparing our results with those obtained elsewhere it is necessary to remember that the method and apparatus of the several authorities referred to are widely different and the results, therefore, are not entirely comparable. Many of the conflicting conclusions may be ascribed to this cause.

Whipple (8, p. 191) gives Weber as citing in one place an index of efficiency (the ratio of absolute difference limen to the standard weight) of 3/32, and in another place 1/40, and Seashore as giving indexes of 1/17 or 1/24. Whipple himself obtained an average DL of 4.7 g. for eighth-grade boys, an index of 1/17. (Assuming our 14-year boys to be in the eighth grade, our average for five eighth-grade boys is 5.2 g., an index of 1/15.)

From Miss Thompson's results, whose apparatus and method are closely similar to ours (altho she uses a standard of 100 g.), we have computed an average DL of 7.2 g. for 25 men, and 8.6 g. for 25 women, a total average of 7.9 g., index of efficiency 1/13, for adult men and women (7, p. 36).

Burt and Moore (2, p. 369) give a median discrimination of 8.5 g. for boys and 12.5 g. for girls. Burt also gives (3, p. 20) an average of 8.7 ± 1.5 for elementary school children (ages 12.5 to 13.5) and 9.3 ± 1.6 for preparatory school children (same ages).

Gilbert, following a procedure of discrimination by sorting, with a standard weight of 82 g. gives norms for both sexes at ages 6 to 17 (4, p. 56). To make his results comparable with ours on the same age-basis, we have averaged his results for ages 6 to 12. This yields an average DL of 10.7 g. for boys and 10.8 g. for girls for those who succeeded in the test, an index of 1/8.

Spearman (6) quoted by Whipple (8) gives an index of 1/15 with conditions unfavorable or 1/20 with conditions favorable.

Our own results yield a total average of 6.7 g., index of 1/12, for normal school children aged 5 to 12, and 7.8 g., index of 1/10, for defectives of mental ages 6 to 12, including all chronological ages, for those who succeed in the test. Our totals are not seriously affected by pathological types.

It may not be out of place to remark that the weights employed in the Binet Scale tests, which sometimes have been challenged as being too difficult to discriminate, are well within the limits of normal discrimination. The Binet procedure, moreover, allows either simultaneous or successive lifting, and the instructions are simple ("Give me the heavy one" for the 5-year test, and "Arrange in order of heaviest to lightest" for the 9-year test. At 5 years the comparisons are between 6 g. and 15 g., and 9 g. and 18 g., whereas our results with defectives and normals

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under more difficult procedure and apparatus would warrant certainly 6 and 9, and 9 and 12, since our results indicate a *sensory* capacity of at worst 1/6, as against the index of 2.5 or 2.0 allowed by the Binet test. The usual substitution of 6-15, and 9-18, for the 3-12, and 6-15 of the original tests has also been questioned. Clearly, on the sensory basis, this substitution is permissible. Still further, the test at 9 years has often been called too difficult, and yet on the method we have employed which is less difficult intellectually, but more so sensorially, children of 9 years have an index of at worst 1/10, and should therefore be able to discriminate increases of 1 g. in the Binet weights instead of the 3 g. allowed. This test has also been called difficult for adults. Our data and that of the authorities quoted disprove this also, altho it is true that "a normal subject who would continue to examine and reflect would end by losing the fine sensation of difference" (1, p. 135).

Individual Differences.

To quote Whipple: "The work of every investigator has shown that the capacity to discriminate lifted weights differs very considerably among normal *S*'s, even when age, sex, and practise factors are eliminated. The author found 7 boys in 50 who could discriminate 80 and 81 grams, and one boy who could just discriminate 80 and 97 grams:—several experimenters have found their weights inadequate to measure the wide differences in capacity that they encountered" (8, p. 191). Burt and Moore (2, p. 366) concluded that "the reliability of our results with this test is not high," and cite a reliability coefficient of .68. Computations from Miss Thompson's results show for 25 men a variability of from 4 to 14 grams with a mode at 6 g., and an arithmetic average of 7.2 g., m.v. 2.1; and for women a variability of from 4 to 16 grams with a mode at 6 g., and an arithmetic average of 8.6 g., m.v. 3.3, a total coefficient of variability of .35. Computations from Gilbert's table for totals at ages 6 to 12 show an m.v. of 4.3, a coefficient of variability of .40. Gilbert's curve of the statistical mean variation shows a gradual decrease in variability with increase in age. Our own results show for normal children individual variations of from 2 to 20 grams, with a total m.v. of 1.1 for ages 5 to 12; for defectives our results show individual variations of from 3 to 20 grams, with a total m.v. of 1.9. On the basis of subjective impressions we should expect, as Burt and Moore find, a rather low reliability coefficient.

Correlations with Age.

Spearman found that his experiments "quite concorded in that the younger children were almost equal to the older ones, and both were not far from adults," and that in old age there is found "no appreciable loss of power" (6, p. 235). Gilbert, on the contrary, shows marked increases in discrimination with increase of age from 6 to 13 years, with little or no im-

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provement after that age. Miss Thompson's averages for men and women, 7.9 g., are higher than Whipple's for eighth-grade boys, 4.7 g., and for our normal children, 6.7 g., but are lower than Burt's school children, 9.0 g. Our results with normals show marked increases in discrimination for increases in age from 5 to 14 years, with a correlation of $r = +.65$ for ages 5 to 12. For defectives our results show almost no differences with chronological age. Arranged in order of chronological age within mental age classification we find for Type III:

Mental age	8	9	10
Pearson r	+.17	+.19	—.24
Cases	41	20	16
Age-Range	8—37	9—27	14—35

in which the increases in age are gradual and fairly even. An inspection of the tables for correlation between age and types of success yields negative conclusions also, these types being functions of mental rather than chronological age. *In our opinion increase in discriminative capacity is a function of intellectual rather than physical maturation.*[8]

Sex Differences.

Gilbert's results for ages below 12 show boys superior to girls at 6 ages, inferior at 4, and equal at 2. Averaging his data for these years yields a sex superiority of 1% in favor of the boys. After the age of 13, however, boys are consistently superior. Spearman (6, p. 235 f), on the other hand, seems to challenge this, and asserts with regard to sex differences in adults that "both sexes appeared perfectly equal in all three senses (pitch, light, and weight) tested; no support whatever was given to the popular assertion that men are much superior." Spearman further affirms (p. 261) that "the fluctuating differences of sensory discrimination observable in connection with sex at the various stages of growth (referring to Gilbert) are chiefly and perhaps altogether a mere consequence of similarly fluctuating differences in their intelligence." But Miss Thompson found men 16% superior to women with DL's of 7.2 g. and 8.6 g. Burt and Moore also find boys markedly superior to girls with medians of 8.5 g. and 12.5 g., respectively (2, p. 369), and with only 2% of boys exceeding the median for girls. They also give (2, p. 364) 66% of men exceeding the median for women, with the general conclusion that "boys and men seem decidedly the more acute. The sex differences in children and adults appear to be about + 40 per cent." (p. 366). Our results show only slight sex differences in both groups. For the normal children boys are superior at 4 ages,

[8]We note that Dr. Marie Lipska-Librach (9) has recently presented a thesis "On the Relations between Sensory Acuity and Intelligence," based on an experimental study of 420 Brussels school children, in which she reaches practically the same conclusions. The subjects of the experiment were classified into 9-10, 10-11, and 11-12 year groups, and further subdivided into *retardés*, *réguliers*, and *avancés*. Experiments were made in tactile acuity, sensitivity to pain, visual acuity, auditory acuity, and strength of grip. In general, the more intelligent children showed greater acuity than the less intelligent, and the older children greater acuity than the younger.

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inferior at 5, and equal at 1, with a sex superiority (for ages 5 to 12) of 5.5%. For the defectives the differences are also slight, being, however, in favor of the girls, with a superiority of 2.5%, which rises to 6.5% for "pure feeble-minded."

Correlations with Intelligence.

Pearson found a corrected correlation of +.44 between general intelligence and weight discrimination. Burt and Moore (2, p. 369), on the other hand, find a correlation of —.16. Burt also maintains that it is not unnatural to find little or no relation between capacity in this test and intelligence, because the sense of weight is "poor in cognitive quality and plays but a lowly part in the conscious life of man" (3, p. 7). Apparently Spearman's "general intelligence" is based on relative "common sense" and cleverness in school. Burt's estimate of intelligence was based on the ratings of the children (who were of approximately the same age) furnished by headmaster, teachers, examination lists, and schoolfellows' evaluations. Our correlations are with intelligence based on mental age as determined by the Binet Scale. For our normal children (at least those below 13) chronological age may be taken as a measure of mental age, altho it is true that our so-called normal children include backward as well as advanced and normal children. For a given group these probably compensate, and it is likely that the resulting error is but slight. Taking, then, chronological age of normals as a measure of mental age, and this as a measure of intelligence, we find a correlation between intelligence and discriminative capacity of +.65 for normal children aged 5 to 12. For defectives, mental age as measured by the Binet Scale may be taken as a safe measure of intelligence, with a resulting correlation of +.36.

Correlations with Other Tests.

Burt furnishes (3, p. 18) a table of "hierarchy of coefficients" for a series of mental tests among which lifted weights is included. In his results there is no significant correlation between this and other tests, the highest correlation being +.29 between weight and touch.

Effects of Fatigue and Practise.

We have no objective data for determinating the effects of fatigue or practise. On the basis of impressions gained during the conduct of the tests there is almost no effect of practise, but fatigue is rather rapid. With defectives the number of comparison series was more than with normals, probably due to the lower intensity of application and attention during the experiment and to their greater variability. "The consensus of opinion is that—the discrimination of lifted weights is but little affected by practise" (8, p. 192). Spearman (6, p. 233), too, thinks "Practise seems to have remarkably little effect," except for fore-exercise where "sometimes the improvement is enormous."

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General Conclusions and Implications.

We are now in a position to consider the chief question of our experiment—Are the feeble-minded appreciably inferior to persons of normal intelligence in sensory capacity? As measured in the muscle sense by acuity in the discrimination of lifted weights we must, as has been seen, take into account the method of classification and treatment on which the comparison is based. We have pointed out that for defectives, by weighted arithmetic averages, there is a marked positive correlation with intelligence and that there is no correlation with chronological age, either regardless of mental age classification or within it. We have also demonstrated that with normal children there is an even more marked positive correlation with chronological age, which for these ages may be taken as mental age. It therefore follows that sensory discrimination as evidenced in this test is a function of intelligence. And this is what might have been expected *a priori,* since the factors involved in the test are chiefly mental; attention[9] or concentration with prolonged application to one directing idea, memory, and judgment following the idea of comparison.[10] Since it is generally conceded that defectives have in these respects an inferior capacity even at the same mental ages, it is to be expected that defectives will show an apparent weakness in sensory capacity which is in reality a weakness in intellect. The difference limens obtained would also be expected to have a lesser degree of reliability, be more variable, and be less acute than those of normals, all of which has been demonstrated in our data. When, therefore, in the face of these disadvantages we find only a slightly lower average discrimination, which is not at all evident in absolute DL's of individual performances, we feel justified in concluding that in the purely sensory capacity, aside from intellectual factors, defectives are not at all inferior to normals of the same intellectual capacity. We do not pretend to have conclusively demonstrated this point for all the senses, nor indeed even for the one under examination, since our experiment may be imperfect in some particulars. This is a matter

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[9]Mitchell (5) says of distractions: "Contrary to the traditional view, distractions (a) increase the precision of judgment, that is, the subject's judgments are more consistent, and (b) cause an overestimation of the weight, or, in other words, with a decrease of attention there is an increase in sensation intensity." This certainly is not the case with incidental and accidental distractions in the presence of weak attention, whatever may be the case with constant distractions of an experimental nature.

[10]Burt (3, p. 7) is of the opinion that "In a task so unfamiliar—as an experiment upon the lower senses much will depend upon the child's interest, conscientiousness, and care—upon his intelligence, not as operating thru or in connection with the sensory function tested, but as helping him to understand the experimenter's instructions and to comply with them in the performance of a difficult and tedious introspection."

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for more careful and extended study, on which we are now at work in other sense departments. So far as we have at present been able to make a few more or less scattered tests in discriminations of length, and some tests in tapping, steadiness, and muscular memory, we do not find any marked inferiority except what might be expected on the basis of mental factors, such as attention, memory, judgment, will, and the like. With defects of these factors present, there is, evidently, a pseudo-defect of sensory capacity which is more apparent than real. Our experiments may be considered merely indicative of a very fruitful line of research rather than as having proved an hypothesis. In this connection, however, the results obtained by Dr. Lipska-Librach are most interesting and suggestive.

With respect to this point we venture again to refer to Binet, whose experiments our own confirm: "We have seen that defectives perceive little differences of sensations for weights or lengths almost as exactly as we. This is because there is no necessity for reflection, and the thot does not need to evolve; it suffices to have consciousness of an elementary sensation of difference. The act of thot is in itself elementary, and if the state of consciousness has an extreme accuracy, it owes that accuracy only to the perceived sensation, not to the psychological operation consisting in feeling. Moreover, we have already noted that a normal subject who would continue to examine and reflect would end by losing the fine sensation of a slight difference. This is indeed proof that all development of thot without going out to meet the result sought after cannot assure itself except in producing a good state of attention."

In conclusion we wish to indicate an implication which these results have for present-day pedagogy. At the present time experiments in sensory capacities are of considerable import for the pedagogy of normal and defective children. Much time and energy are being expended in meeting the feverish demand for "sense-training," particularly in the special classes and in the primary grades. Most of the Montessōri system has its basis, if not its ends, in the training of the senses to almost hyper-acuity, and to the Montessori movement may be ascribed much of the existing demand for sense-training in general. But very little actual measurement of the results obtained has as yet been attempted. The results from this present experiment certainly indicate that nothing is to be gained from the training of the muscle sense. How far this conclusion applies to the other senses, touch, smell, taste, sight and hearing, is purely a matter of theory and conjecture. The implication certainly is that formal sense-training is not only largely unnecessary, but that the extent and permanence of its effects are open to question. And if sense-training has as its ultimate ends the cultivation of the other faculties, or of the self, then it must meet the negative conclusions that have been obtained in the experimental measurements of transfer of training, formal discipline, etc.

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Summary.

(1) Discrimination of lifted weights is a function of intellectual rather than of sensory capacity.

(2) The discrimination of defectives is, on the average, slightly below that of normals of the same mental age, but this is not apparent from individual performances. Defectives also are more variable than are normals. Both of these inferiorities may be accounted for on an intellectual rather than a sensory basis. In general, *the sensory capacity of defectives in muscle sense is not noticeably below normal.*

(3) There is a positive correlation with intelligence but no correlation with chronological age except where these are identical.

(4) The test is not diagnostically valuable except in the types of success in following instructions. Inability to do the test in the prescribed way indicates a mental age of below 8 years.

References.

1. A. Binet et Th. Simon, L'Intelligence des Imbéciles, L'Année Psychologique, 1909, Vol. XV.

2. Burt, Cyril, and Robt. C. Moore, The Mental Differences Between the Sexes, Jour. Exp. Ped., December, 1912, Vol. I, No. 5.

3. Burt, Cyril, The Experimental Study of General Intelligence, Reprinted from Child Study, Vol. IV, 1911.

4. Gilbert, J. A., Researches on the Mental and Physical Development of School-Children, Studies from Yale Psych. Lab., November, 1894, Vol. II.

5. Mitchell, David, Influence of Distractions on the Formation of Judgments in Lifted Weights Experiments. Psy. Bul., February, 1914, Vol. XI, No. 2, p. 48.

6. Spearman, C., General Intelligence Objectively Determined and Measured, Am. Jour. Psy., April, 1904, Vol. XV, No. 2.

7. Thompson, Dr. Helen B., The Mental Traits of Sex, Chicago, 1903, p. 36.

8. Whipple, G. M., Manual of Mental and Physical Tests, Baltimore, 1910, pp. 188-194. (Revised 1914, Vol. I, pp. 223-230.)

9. Lipska Librach, Dr. Marie, Sur les rapports entre l'acuite sensorielle et l'intelligence. Revue Psychologique, September and December, 1913, Vol. VI, Nos. 3 and 4.

Additional bibliography in references cited, especially in 8.

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